

Neutrons, Gamma Rays, and Beta Particles Interactions with IIAO  
Films Flown on Astro I and Astro II and Comparison  
With IIAO Flown on the Get-Away- Special STS-7

Ernest C. Hammond, Jr., Kevein Peters, and Kevin Boone  
Morgan State University, Baltimore, Maryland

ABSTRACT

The current requirements for the Laboratory for Astronomy and Solar Physics, sends rocket satellites and in the near future will involve flights in the shuttle to the upper reaches of the earth's atmosphere where they will be subjected to the atomic particles and electromagnetic radiation produced by the sun and other cosmic radiation. It is therefore appropriate to examine the effect of neutrons, gamma rays, beta particles and X-rays on the film currently being used by the Laboratory for current and future research requirements. It is also hoped by examining these particles in their effect that we will have simulated the space environment of the rockets, satellites and shuttle. Several samples of the IIAO film were exposed to a neutron howitzer with a source energy of approximately 106 neutrons/steradians. We exposed several samples of the film to a 10 sec. blast of neutrons in both metal and plastic containers which were produced by Kodak. At the intensities mentioned, the film in the metal container exhibited higher density readings which indicated the possibility of some secondary nuclear interactions between neutrons and the aluminum container. The plastic container showed some variations at the higher densities. Exposure of the samples of IIAO film to a neutron beam of approximately 10 neutrons per steradians for 8 minutes produces approximately a thirteen percent difference in the density readings of the dark density grids. It is noticeable that at the lighter density grid the neutrons have minimal effects, but on a whole the trend of the 8 minute exposed IIAO film density grids at the darker end had a 7.1 percent difference than the control. Further analysis is anticipated by the increasing the exposure time. Two sets of film were exposed to a beta source in a plastic container. The beta source was placed at the bottom so that the cone of rays striking the film would be conical for a period of seven days. It is observed in the film designated 4a and 4b a dramatic increase in the densities of the grids occurred. One can observe the attenuation of beta particles due to the presence of air. The darker density grids since its position was furthest from the beta source displayed minimal fluctuations as compared with the control. It is suspected that the orientation of the film in the canister with the beta source is the key factor responsible for the dramatic increases of the lighter density grids. Emulsions #3a and 3b exposed for a period of six days with the grid orientation reserved produced substantial differences in the darker grids as shown in the graphs. There is a great deal of fluctuations in this sample between the beta exposed density grids and the control density grids. The lighter density grids whose orientations was reversed displays minimal fluctuations due to the presence of this beta source and the attenuation that is taking place.

## **Neutron Interaction**

Using Morgan State University Neutron Howitzer for varying lengths of exposure the H&D curve shows an increased fog level at the shoulder or is substantially fogged. The controls are relatively well behaved except for pronounced reciprocity failure for both the controls the neutron exposed film. In one sample set it was observed that the neutrons seemed to have some effect on the very transparent grains and small amount of fogging occurs.

## **Gamma Rays**

Examinations of the data using a gamma ray source seems to produce a remarkable separation of at the linear portion of the H&D curves. This separation is remarkable for both, at the toe and shoulder of the H&D curve. This separation is unobserved. But it is remarkable that at longer exposures of gamma rays from the gamma ray source, the lower densities of large grains seem to increase substantially at both the toe and shoulder of the H&D curves.

## **Beta Particles**

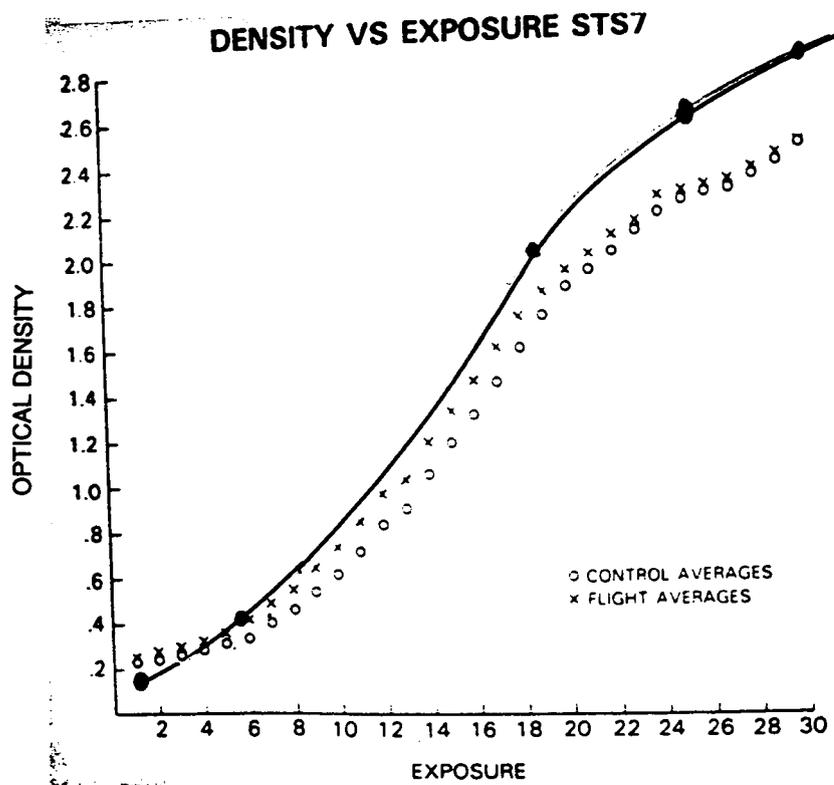
Looking at the effect of the beta particles over a period of six days. With the grid orientation reversed, differences can clearly be seen at the linear density wedges while the beta particles tend to effect the higher density of the film. Reversing the beta particles source within the plastic canister tend to effect the fogging levels for the lower density wedges. So in conclusion, the closer the source of the beta particles to the film will cause sensitometric fogging increases recorded on the film.

On STS7 the separation between the linear portion of the H&D curve is substantial and is reasonably comparable to the gamma ray effects. An STS50 averaging all the individual step wedges produced a substantial separation at the lower density wedges, while at the darker density wedges for the flight film produced reduced fogging or some type of reciprocity failure which was compared to both neutron and gamma ray. An examination of alpha particle interaction at three major energies seems to confirm that the higher energy particles produce greater damage at the low density wedges. Current data from the most recent flights on the shuttle are being analyzed.

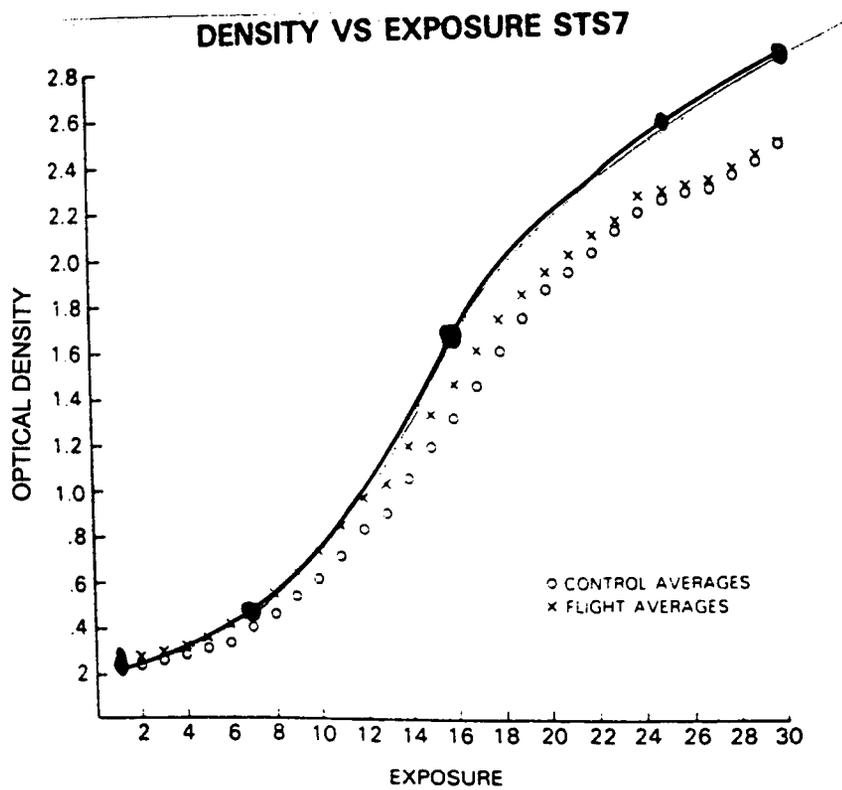
## Conclusion : Radiation Effects as Related to Flight Film

After the examination of neutron, gamma ray and beta particle interaction with the control film, let us compare these results to the density versus exposure for STS7 films flown on the Get-Away -Special. The neutrons show an increase in fogging at the shoulder of the H and D curve. There are no such increase observances on the films flown on STS7. The laboratory gamma ray exposure shows some slight statistical change between the control and the flight film. There is a slight similarity just above the toe of the H and D curve which can be clearly associated with some type of gamma or cosmic ray interaction. The beta particle interaction is extremely high at the shoulder and the toe of the H and D curve. We believe that the separation between the control and flight film are primarily due to gamma, cosmic, and thermal ray interaction at much higher density levels.

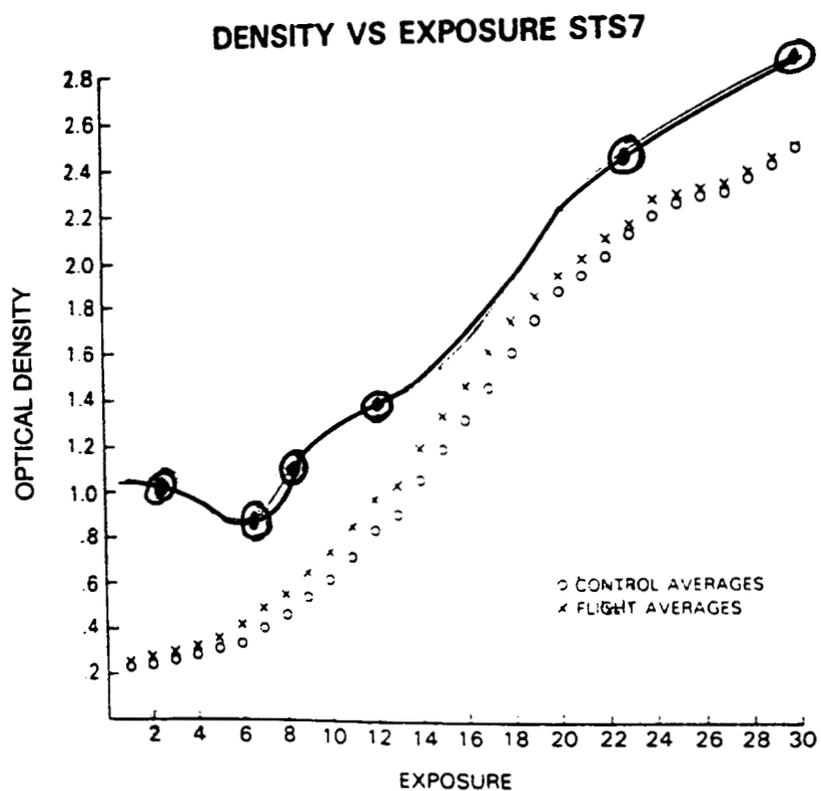
## Neutron Responses Compared to Flight Film



## Gamma Ray Responses Compared to Flight Film



## Beta Particles Responses Compared to Flight IIaO Film



# MoV ENERGY VS. DOSAGE

